شركة أولاد عبدالوهاب عبدالعزيز القطامي
Abdulwahab Abdulaziz Al Qatami's Sons Co.

Power Electronics

Innovative Power Quality Solutions

Our energy working for you.™

Cummins is a global leader in engine technology and service solutions across Power Generation, Industrial and Automotive applications. Its technology and pioneering initiatives include bringing innovative solutions and reliable services at the best possible value to users across the globe. The high performance outlook at Cummins is based on customer focus, integrity and capability of our people.

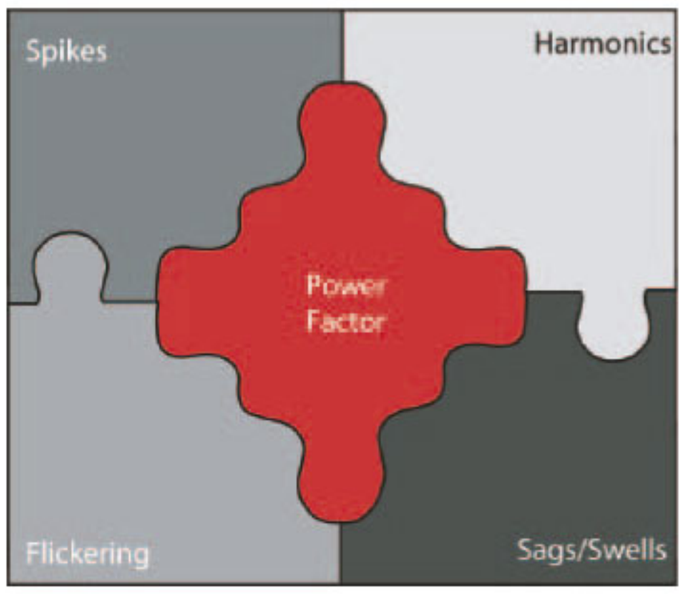
Cummins Inc., USA, is a leader in the design and manufacture of power generation equipment and one of the most integrated providers of power solutions in the world.

Cummins in India, a part of the USD 18 billion Cummins Inc., is a group of 11 entities across 200 locations in the Country with a combined turnover of almost Rs. 8,600 crore and employing more than 11,000 individuals.

Cummins India Limited (CIL) is the Country's leading manufacturer of diesel and natural gas engines. It has produced more than 1, 67,000 engines till date in its state-of-the-art manufacturing facilities, mainly in Pune and Daman. The Company manufactures nearly 20,000 engines and silent gensets on an annual basis.

Cummins Power Generation in India is the market leader in the diesel genset segment with a product portfolio ranging from 15 kVA to 3000 kVA as well as complete power solutions, offering top of the line products like Automatic Transfer Switches (ATS) ranging from 40 Amps to 4000 Amps in open / closed / programmed transition, state of art controller to suite various applications and services. From simple generator sets to turnkey, on-site power stations, Cummins has the expertise to successfully meet the power requirements of a wide range of individual, industrial and institutional users.

Power Electronics



Power Electronics

The Power Electronics Business of Cummins Power Generation offers an innovative range of power consulting services and solutions through its technologically advanced Dynamic Reactive Power Factor Compensation System (DRPC) and the CII-award winning Real Time Power Factor Compensation cum Harmonics Filtration System (RTPFC). Through each of these solutions, Cummins Power Electronics aims at providing quality power solutions to understand and improve the quality of power in the network and monitor the energy.

Power Quality

Power Quality is the function of voltage, current and frequency, a deviation in which may result in equipment failure, process interruption or power system inefficiency. These deviations can manifest themselves in harmonics, power factor, voltage sags / swells / flicker, transients and much more.

An initiative from regulatory authorities in India Recent Electricity Act 2005 has laid down the following directives:

- Encourage customers to maintain a flat load profile
- Bill customers on the basis of kVAHr instead of kWHr
- Customers with a power demand greater than 500 kVA require to declare the harmonic content

Several states including Uttar Pradesh, Himachal Pradesh, Madhya Pradesh, Maharashtra and Tamil Nadu have taken definitive steps to implement these directives.

Power Quality deals with amplitude, frequency and distortion of the electrical signal. It is no longer restricted to input only but is load related as well.

Power Electronics Solutions

Cummins Power Electronics specializes in conducting a comprehensive Power Quality Analysis (PQA) to study the peculiarity of an application, impact of Harmonic levels on sources, rate of change of load for correct evaluation of the solution offered for power factor improvement and most importantly correct genset sizing for highly non-linear loads

Cummins Power Electronics provides world-class customized solutions like:

- Power Quality Analysis
- Real Time Power Factor Compensation cum Harmonic Filtration System (RTPFC)
- Dynamic Reactive Power Factor Compensation cum Harmonic Filtration System (DRPC)

Criteria for selecting Power Quality improvement solution:

- **Rate of change of load**

In industrial applications, majority of the loads draw considerable amount of reactive power due to the inductive nature of the loads. Normally, a load's reactive power compensation changes with the rate of change of load. The effectiveness of the reactive power compensation depends on the response time of the compensation device. In case of fixed linear loads, compensation by slow response TSC (response time up to <100 ms) is adequate.

Due to the recent advent in the area of power electronics and its applied applications, nonlinear fast varying loads like Variable Frequency Drives, Spot Welding, Rolling Mills, Induction Furnaces, Vacuum Furnace and Traction are commonplace. These demand very fast reactive power compensation cycle-to-cycle response in 20 ms.

■ Capacitor switching technique

Today, contactor switched APFC is the most commonly used reactive power compensating technology. However, it is associated with current spikes, generated due to the capacitor being switched at non zero instants on the voltage waveform. Normally, this increases the level of current harmonics in the network. These systems are sluggish in response, leading to overcompensation resulting in voltage flicker. They prove to be of very little assistance when the rate of change of load is faster.

This calls for a transient free, reactive compensation system with cycle to cycle response and a zero cross over switching, restricting the increase in current harmonic levels while switching capacitors.

■ Type of loads - Balanced and Unbalanced loads

In recent years, majority of the loads which were hitherto balanced have become unbalanced in nature.

Also, loads distributed in a balanced manner across all three phases may not necessarily remain balanced if a section of a single phase load is switched on or off. Today's software companies are a common example of such unbalance experienced in day to day practices. This situation leads to an unbalance in power factor across three phases.

Since the reactive power systems, available to the industry, are essentially balanced type of compensation, they do not offer effective compensation for unbalanced loads and thus call for a dedicated solution for unbalanced loads providing phase to phase reactive compensation.

■ Genset Compatibility

Today, the existing demand supply gap scenario for power is increasing the dependency on gensets, like never before. The reactive power solution designed for transformers may not necessarily be compatible for gensets on account of different values of source impedances. In normal practice, the reactive power compensation solution is switched off when the power source is a genset. In the event of a power outage the non-linear load that a genset has to feed essentially remains the same, irrespective of the number of switches between an infinite bus (Electricity Board) and a weaker source (genset). This calls for a Source Independent Reactive Compensation System offering compensation for a transformer as well as a genset.

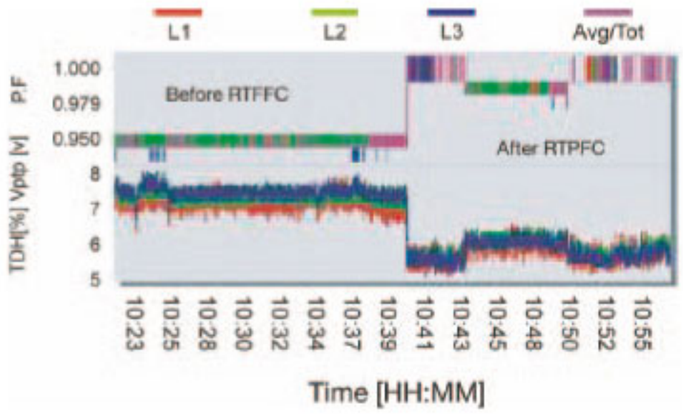
Gensets are designed for linear loads. When they are subjected to large amounts of non linear loads, gensets may not be able to cope. Genset compatibility of a reactive compensation system means enabling the genset to cope with such demanding loads.

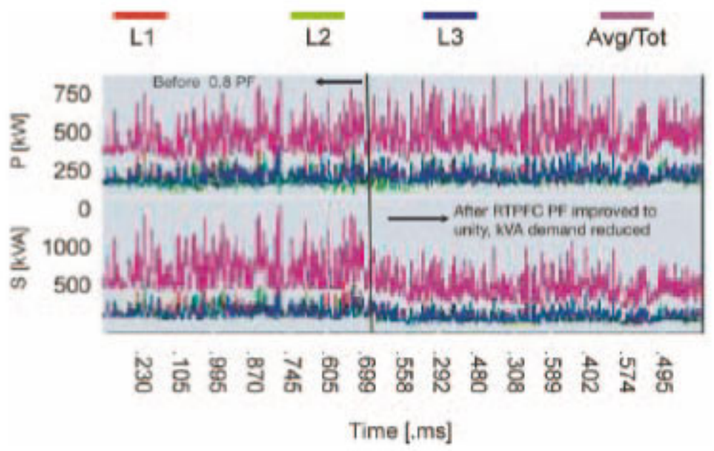
■ Harmonic mitigation

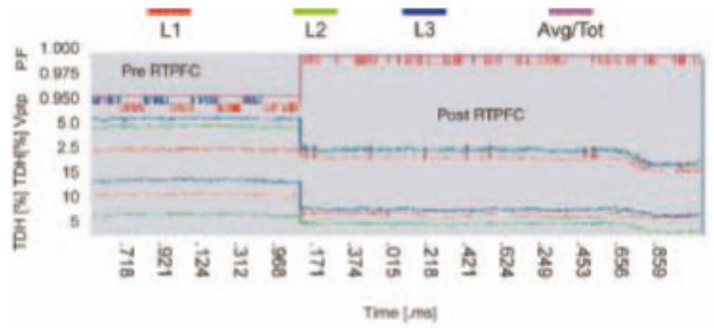
In most applications the predominant levels of harmonics are the lower order harmonics. Hence, treatment of these harmonics levels is generally sufficient.

■ Applications

Cummins compensation systems are all- in- one solution for power quality problems, typically installed near the main service and near major distribution panels to provide dynamic reactive power compensation for balanced and unbalanced loads for mains as well as genset.







Pre RTPFC installation THD I level over 10% & THD V level over 5%. Post RTPFC installation THD I & V reduced up to 50%.

Power Quality Analysis (PQA)

Cummins specializes in conducting comprehensive Power Quality Analysis. For optimum utilization of Power in the electrical network it is necessary to know the present status of Power Quality. With our state of art equipments we are able to conduct three phase on line measurements without affecting normal operation of plant. The sampling rate for collecting these parameters can be adjusted based on the behaviors of the respective electrical networks & load variations. The data collected at respective feeders is then compiled and analyzed together considering the load requirements and its effect to identify the areas where overall Power Quality needs to be improved. Several parameters are identified which require special treatment.
The PQA can be conducted on L.T. & H.T. side depending on load requirements.

The consolidated PQA report is then prepared with the help of actual instantaneous values recorded. Tabular and graphical representation for all recorded parameters is provided to understand exact behavior of power & load. The instantaneous snapshots of the waveforms for several parameters are also recorded during online measurement. These snapshots help to understand exact & accurate requirement for typical network.

Based on the data collected during analysis & with our expertise in power quality we offer appropriate solution. The consolidated PQA report is accompanied with the **'CUMMINS Power Quality Solution'** for electrical network.

Parameters recorded during PQA are:

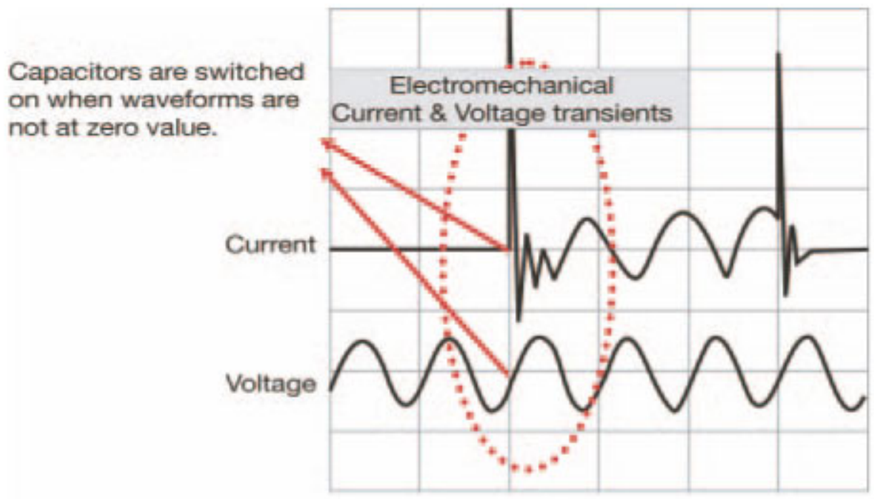
- System RMS Voltage - Phase Wise
- System RMS Current - Phase Wise
- Total Harmonic Distortion Voltage
- Total Harmonic Distortion Current
- Individual Current Harmonics - Up to 63rd Order
- Individual Voltage Harmonics - Up to 63rd Order
- Active Power
- Reactive Power
- Displacement Power Factor
- True Power Factor
- Current Variation
- Voltage variation
- Voltage Unbalance (IEEE / IEC)
- Current Unbalance (IEEE / IEC)
- Voltage flickers
- Surges / Transients
- Waveform snapshots

Advantages of Thyristor switched systems over Contactor switched systems.

Parameters	Conventional Contactor switched systems	Thyristor switched systems
Switching Device	Electromechanical contactors	Thyristors
Response Time	Very slow & delayed response	Ultra fast response is possible
Overcompensation & Under-compensation	Possibility due to delayed response	Not possible
Switching	Anywhere between duty cycle	At zero crossings only
Compatibility	Operative only in presence of mains supply	Can work with both D.G. & mains supply
Problems associated with switching	Spikes, glitches & transients are generated also response becomes sluggish	No problems due to switching at zero crossing
Capacitor life	Capacitor derates faster & life reduces due to above mentioned parameters	Long life with optimum performance is ensured due to thyristor switching
Reactor	Reactor is overheated, panel temperature increases which adversely affects capacitor life, large possibility of burnouts	Due to smooth operation reactor heating is well under control. So reactor offers long life without humming.
Switching Mechanism	Contactors lead to sparking, imbalance, also reduces system life significantly	Thyristors ensure smooth & safe switching of banks without any system glitch
Efficiency	Much lesser efficiency due to lower accuracy of the system.	Most efficient system since real time compensation is provided. System accuracy is higher
Operating cost	Repetitive replacements of components & servicing largely increases operating cost.	Due to ideal operating conditions least failures occur so operating cost is less
ROI	ROI is low, also the system performance degrades faster due to electromechanical switching & operational cost increases due to premature failures	ROI is higher & stable performance of the system over the long period of time reduces operational cost to great extent

Non-zero switching

Conventional systems switching at non-zero instants generate heavy inrush currents. Resulting in damage of capacitors, increase in harmonic distortion, reduction in overall system life.



Electromechanical vs. Transient - free switching.




General Overview of Quality Components

Controller - Unique design of controller caters fast varying demands of various types of loads.
The controllers are available in single & three phase control options. The controller is equipped with several features like programmable switching sequence, least acquisition time, closed loop control mode, capacitor test, advanced options for power quality measurement & control.

Thyristor Switching Module - TSM is comprised of firing card which controls switching of banks at zero crossings only. The module is provided with all protections against temperature. Thyristors used are rugged with appropriate PIV ratings. Electronic & power section isolation is provided. The design ensures max heat dissipation, long life & accurate working of module.

Reactors - The copper wound & ferrite core reactors are used. The proper spacing of turns is maintained to ensure maximum heat dissipation. High class epoxy insulation ensures long life of reactors. Reactors are typically customized as per the system requirements.

Capacitors - Specially designed capacitors are used which provide super heavy duty with extra life. The imported technology of Metalized Poly-Propylene provides longer capacitor life. Discharge resistors are selected to ensure faster discharge of capacitors. The specially designed capacitors can bare higher dielectric stresses. The capacitor technology & design ensures peak performance throughout operating life.



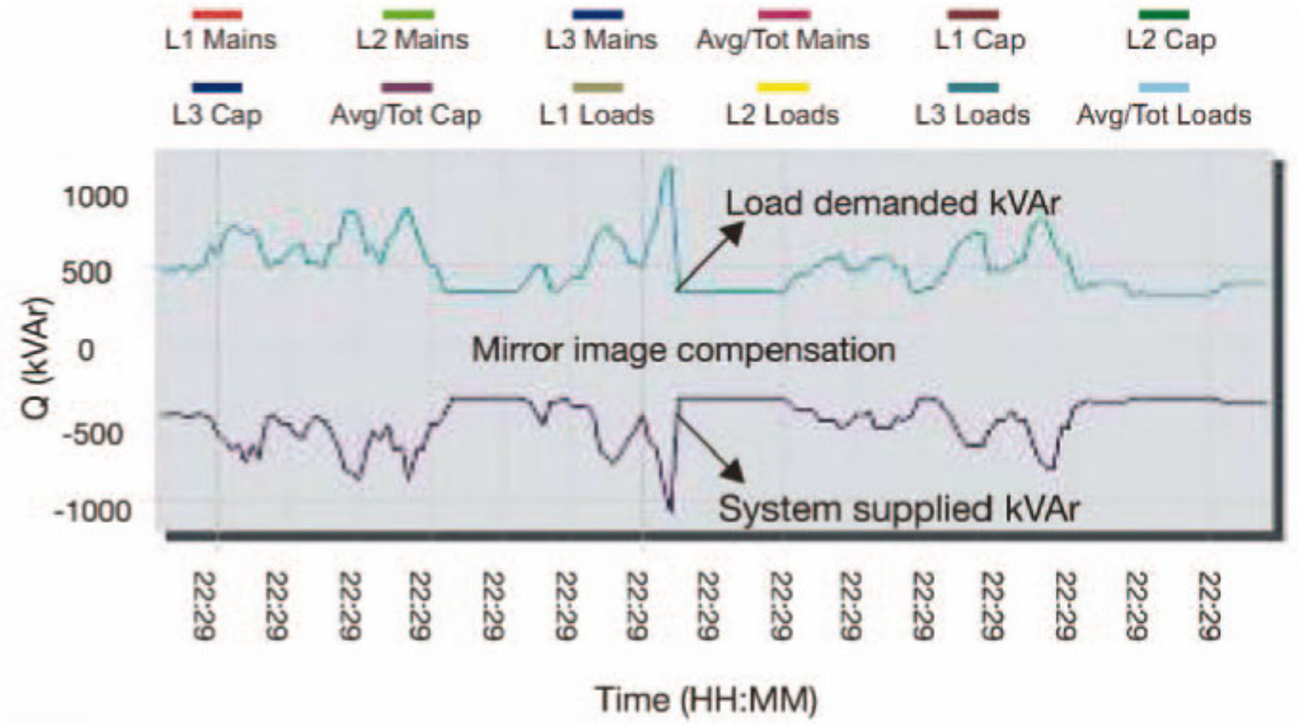

Technical Specifications for Cummins RTPFC & DRPC systems

Technical Description	RTPFC	DRPC
System Ratings	230 VAC to 690 VAC, 1/3 phase, 50Hz	415 VAC to 440 VAC, 3 phase, 50 Hz
Compensation Type	Balanced & Unbalanced compensation for Power Factor & Harmonics	Balanced compensation for Power Factor & Harmonics
Response Time	Ultra fast response < 20 ms	Fast response < 100 ms
Control System	Thyristor switched Transient Free control system, based on Zero Crossing Technique with faster closed loop control	Thyristor switched Transient Free control system, based on Zero Crossing Technique with faster closed loop control
Ambient Temperature	45 deg. C	45 deg. C
Enclosure	Standard Steel Sheet Cabinate, Powder coated with RAL 7035 Siemens Gray, IP40 Other class available on request	Standard Steel Sheet Cabinate, Powder coated with RAL 7035 Siemens Gray, IP 40 Other class available on request
Capacitors		
Type	Single or Three phase, Super Heavy Duty, Long Life, Dry Type, Self Healing MPP type capacitors	Three phase, Super Heavy Duty, Long Life, Dry Type, Self Healing MPP type capacitors
Safety Feature	Over Pressure Disconnector, Accurate value of Discharge resistor, longer switching life, High dielectric stress level	Over Pressure Disconnector, Accurate value of Discharge resistor, longer switching life, High dielectric stress level
Harmonic Block Reactor		
Type	Single or Three phase, Special single layer design with step core for lower losses & stable performance.	Three phase, Special single layer design with step core for lower losses & stable performance.
Linearity	200%	200%
Insulation Class	'H' class insulation with vacuum impregnated	'H' class insulation with vacuum impregnated
Detuning Factors	7% & 14%	5.6%, 7% & 14% or any filtering factor on request

Technical Description	RTPFC	DRPC
Thyristor Switching Module		
Thyristor PIV	2200	2200
Protection	HRC Fuses	HRC Fuses
Controller		
Type	DSP / VLSI based system upto 12 steps, Higher resolution Full Graphic 160 x 128 pixels display with capacitor scan mode	DSP / VLSI based system upto 16 steps, Higher resolution Full Graphic 128 x 64 pixels.
Measuring System	Specially designed DSP / VLSI based FFT algorithm for minimal response time	Specially designed DSP / VLSI based FFT algorithm for minimal response time
Measured & Display Parameters	Vrms, I,P.F., T.H.D. I, T.H.D. V, kVA, kVAR, f, kW, KWH, KVARH, Capacitor Parameters	Vrms, I,P.F., T.H.D. I, T.H.D. V, kVA, kVAR, f, kW, Temperature
Parameter Measurements at	Mains, load & Capacitor	Mains
Communication (Optional)	RS-485	RS-485/Ethernet
Application Areas	Welding loads, CNC machines, Induction furnaces, ultra fast varying loads	fast dynamic loads
Safety Standards (Over Voltage Class)	EN 61010 - 1 and EN 50439 - 2	II, pollution degree 3 (DIN VDE 0110, Teil 1/IEC 606641)
EMC Standards	EN 50081 - 2, EN 50082 - 2, EN 55011, EN 61000 - 4 2/3/4/5, ENV 50204 and ENV 50142	DIN VDE 0110 Teil 1(IEC 606641:1992), VDE 0411 Teil 1 (DIN EN 610101/IEC 610101:2001), VDE 0843 Teil 20 (DIN EN 61326/IEC 61326:1997 + A1:1998 + A2:2000)

Mirror Image Compensation

Cummins systems have this unique feature for compensating demand by replication of required kVAr which provides most accurate results.



Configurations for RTPFC System

Typical dimensions for balanced compensation

Output kVAR	Step Size kVAR	Controller Group	Banking	Switching sequence	Dimensions W X D X H (mm)	INCOMER rating (A)	Voltage (V)	Frequency (Hz)
125	25	3	1x25, 2x50	1:2:2	800 x 800 x 2100	250	415/440	50
150	30	3	1x30, 2x60	1:2:2	800 x 800 x 2100	400	415/440	50
175	25	3	1x25, 1x50, 1x100	1:2:4	800 x 800 x 2100	400	415/440	50
200	40	3	1x40, 1x80	1:2:2	800 x 800 x 2100	400	415/440	50
210	30	3	1x30, 1x60, 1x120	1:2:4	800 x 800 x 2100	400	415/440	50
231	33	3	1x33, 1x66, 1x132	1:2:4	800 x 800 x 2100	400	415/440	50
250	50	3	1x50, 2x100	1:2:2	800 x 800 x 2100	630	415/440	50
300	60	3	1x60, 2x120	1:2:2	800 x 800 x 2100	630	415/440	50
350	50	3	1x50, 3x100	1:2:4	1200 x 800 x 2100	630	415/440	50
360	120	3	3x120	1:1:1	800 x 1200 x 2100	630	415/440	50
363	33	3	1x33, 1x66, 2x132	1:2:4 1	600 x 800 x 2100	630	415/440	50
480	80	6	6x80	1:1:1	2400 x 1200 x 2100	1000	415/440	50
495	33	6	1x33, 1x66, 3x132	1:2:4	2400 x 1200 x 2100	1000	415/440	50
550	50	6	1x50, 5x100	1:2:2	2400 x 1200 x 2100	1000	415/440	50
600	100	6	6x100	1:1:1	2400 x 1200 x 2100	1250	415/440	50
627	33	6	1x33, 1x66, 4x132	1:2:4	2400 x 1200 x 2100	1250	415/440	50
660	60	6	1x60, 5x120	1:2:2	2400 x1200 x 2100	1250	415/440	50
720	120	6	6x120	1:1:1	2400 x 1200 x 2100	1600	415/440	50
891	33	9	1x33, 1x66, 6x132	1:2:4	3200 x 1200 x 2100	2000	415/440	50
900	100	9	9x100	1:1:1	3200 x1200 x 2100	2000	415/440	50
1023	33	9	1x33, 1x66, 7x132	1:2:4	3200 x1200 x 2100	2000	415/440	50
1080	120	9	9x120	1:1:1	3200 x 1200 x 2100	2000	415/440	50
1200	100	12	12x100	1:1:1	4000 x 1200 x 2100	2500	415/440	50
1419	33	12	1x33, 1x66, 10x132	1:2:4	4000 x 1400 x 2100	3200	415/440	50
1440	120	12	12x120	1:1:1	4000 x 1200 x 2100	3200	415/440	50

Typical dimensions for unbalanced compensation

Output kVAR	Step Size kVAR	Controller Group	Banking	Switching sequence	Dimensions W X D X H (mm)	INCOMER rating (A)	Voltage (V)	Frequency (Hz)
294.3	98 (3 X 32.7)	2	3x32.7, 3x65.4	1:2:2	1600 x 800 x 2100	630	415/440	50
343.5	49 (3 X 16.4)	3	3x16.4	1:2:4	2400 x 800 x 2100	630	415/440	50
490.5	98 (3 X 32.7)	3	3x32.7, 6x65.4	1:2:2	3200 x 1200 x 2100	1000	415/440	50
539.7	49 (3 X 16.4)	4	3x16.4	1:2:4	3200 x 1200 x 2100	1000	415/440	50
686.7	98 (3 X 32.7)	4	3x32.7, 9x65.4	1:2:2	3200 x 1200 x 2100	1250	415/440	50
882.9	98 (3 X 32.7)	5	3x32.7, 12x65.4	1:2:2	4000 x 1200 x 2100	1600	415/440	50
1079.1	98 (3 X 32.7)	6	3x32.7, 15x65.4	1:2:2	4800 x 1400 x 2100	2000	415/440	50
1275.3	98 (3 X 32.7)	7	3x32.7, 18x65.4	1:2:2	5600 x 1400 x 2100	2500	415/440	50
1471.5	98 (3 X 32.7)	8	3x32.7, 21x65.4	1:2:2	6400 x 1400 x 2100	3200	415/440	50
1667.7	98 (3 X 32.7)	9	3x32.7, 24x65.4	1:2:2	7200 x 1400 x 2100	3200	415/440	50
1863.3	98 (3 X 32.7)	10	3x32.7, 27x65.4	1:2:2	8000 x 1400 x 2100	3200	415/440	50
2060.1	98 (3 X 32.7)	11	3x32.7, 30x65.4	1:2:2	8800 x 1400 x 2100	4000	415/440	50
2256.3	98 (3 X 32.7)	12	3x32.7, 33x65.4	1:2:2	9600 x 1400 x 2100	4000	415/440	50

** Specifications and dimensional details are subject to change. Any other ratings & customized panels are available on request.*

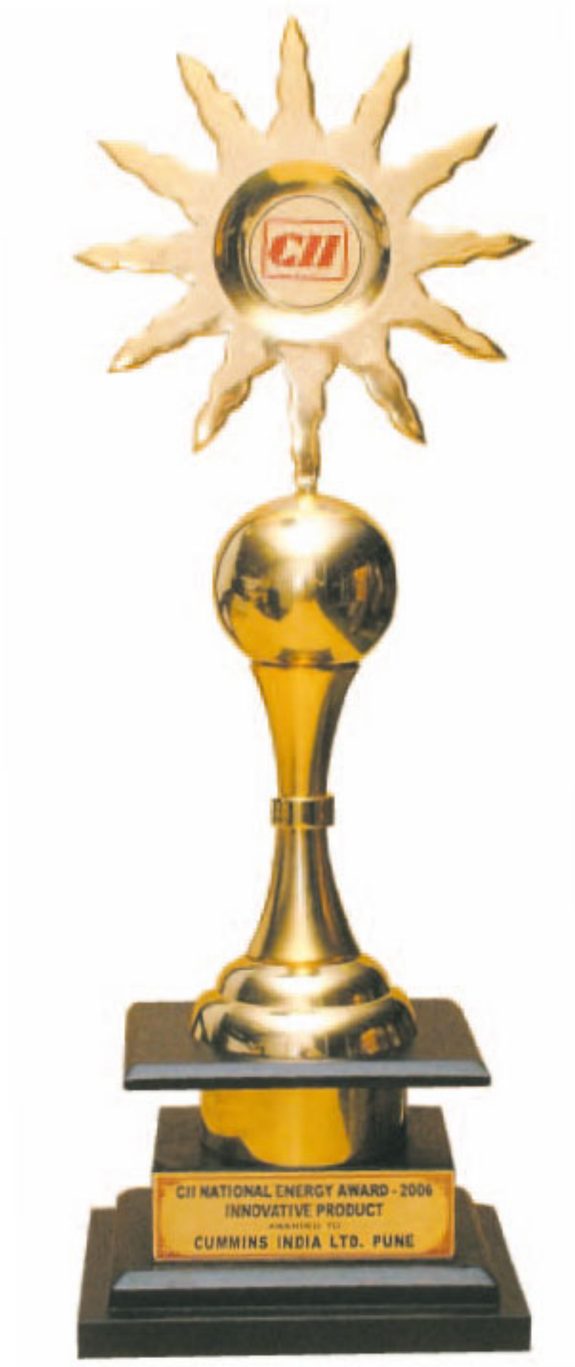
Configurations for DRPC System

Typical dimensions for DRPC system

Output kVAR	Step size kVAR	Banking Configuration	Switching Sequence	Dimensions W X D X H (mm)
100	12.5	2 X 12.5, 3 X25	01:02:02	800 X 850 X 2125
200	12.5	2 X 12.5, 1 X25, 3X50	01:02:04	800 X 850 X 2125
300	12.5	2 X 12.5, 1 X25, 1X50, 2X100	01:02:04	800 X 1150 X 2125
400	25	2 X25, 1X50, 3X100	01:02:04	800 X 1150 X 2125
500	25	2 X25, 1X50, 4X100	01:02:04	2400 X 1150 X 2125
600	25	2 X25, 1X50, 5X100	01:02:04	2400 X 1150 X 2125
700	25	2 X25, 1X50, 6X100	01:02:04	2400 X 1150 X 2125
800	25	2 X25, 1X50, 7X100	01:02:04	3200 X 1150 X 2125
900	25	2 X25, 1X50, 8X100	01:02:04	3200 X 1150 X 2125
1000	25	2 X25, 1X50, 9X100	01:02:04	3200 X 1150 X 2125

** Specifications and dimensional details are subject to change.*

** Any other ratings & customized panels are available on request.*



CII National Award honors Excellence in Energy Management

The Power Generation Business Unit of Cummins India Limited has won the Confederation of Indian Industry (CII) National Award for Excellence in power quality. The **"Real Time Power Factor cum Harmonic Filtration System" (RTPFC)**, designed to improve the overall system efficiency and tune out harmonics for power factor control applications, has been recognized as the **"Most Innovative Product that Optimizes Energy Efficiency"**. Also the award has been conferred upon Cummins for its unique **"Power Quality & Adequacy Analysis service designed to ascertain source and load compatibility"** in the Electrical category at CII's Excellence in Energy Management National Awards.

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